Remarks

Claims 1-5, 7-9, 11-20, and 22 remain in the application, of which claims 1 and 16 are in independent form.

Claims 1-5, 7-9, 11-20, and 22 stand rejected under 35 USC § 103(a) for obviousness over U.S. Pat. No. 5,751,585 ("Cutler et al.") in view of U.S. Pat. No. 5,629,790 ("Neukermans et al.").

Regarding claims 1 and 16, the Examiner states that Cutler et al teaches the apparatus substantially as claimed except for a two-axis steering mirror, but that Neukermans et al teaches a single two-axis steering mirror having a pivot point on the surface of the mirror used to deflect a laser beam toward a target location. The Examiner contends, therefore, that it would have been obvious to use the Neukermans et al. single two-axis steering mirror in place of the Cutler et al. pair of one-axis steering mirrors to reduce the number of parts in the beam steering mirror assembly.

Applicants respond by amending independent claims 1 and 16. Claim 1 is representative and recites in relevant part:

> "1. ... processing circuitry implemented to perform comparisons ... and to provide from the comparisons one or more error signals indicative of a difference between the coordinate position command information and the actual coordinate position, the difference including a transient signal component representing laser beam position errors at the workpiece surface;
>
> a steering mirror controller system producing a position correction signal in response to each error signal provided;
>
> a two-axis steering mirror including a pivot point and positioned to receive the laser beam at or near the pivot point, the two-axis steering mirror, in response to the position correction signal, imparting to the laser beam angular motions that deflect the laser beam in a manner sufficient to compensate for the laser beam position errors; and
>
> a focusing lens having an entrance pupil and positioned to receive the deflected laser beam and focus it on the target location of the workpiece, the entrance pupil being set at or near the pivot point to provide a substantially distortion-free deflected laser beam."

Support for these amendment is found in the descriptions of Figs. 5-7 at ¶¶ [0039] and [0040] of the specification, and of Figs. 11 and 12 from ¶ [0060] to ¶ [0066] of the specification. In particular, ¶¶ [0039] and [0040] describe:

> "... a single high-speed, high-accuracy two-axis steering mirror system 100 that includes a mirror 102 capable of actuation with at least two degrees of freedom. Mirror 102 has a centrally positioned pivot point 104 that preferably coincides with an entrance pupil 106 of a focusing lens 108. ... Because the beam is focused to a very fine spot size for SLP [semiconductor link processing] applications, the mechanism directing mirror system 100 preferably pivots the mirror 102 along at least two axes

about pivot point 104, which is located at or near the entrance pupil of focusing optics or lens 108. Small angle perturbations in the position of mirror 102 deflect the beam enough to correct for linear stage settling errors at the work surface, and because mirror 102 is located at or near the entrance pupil of focusing lens 108, the beam is shifted without distorting the focused spot, allowing delivery of a small, high quality spot."

In a preferred embodiment, the linear stage settling errors described in the above-quoted passage and shown in Fig. 7 correspond to the transient signal component recited in claims 1 and 16.

Applicants submit that Cutler et al. employ a pair of separate galvo mirrors, not a two-axis steering mirror. Cutler et al. show in Fig. 4 and describe at col. 8, line 64 an "optional lens 114" that inherently includes an entrance pupil. However, the entrance pupil of lens 114 can be at or near only the closest one of the two galvo mirrors. Deflection of the farthest galvo mirror translates the laser beam across the closest galvo mirror and causes spot distortion (astigmatism similar to keystoning errors and defocusing aberrations caused by path-length changes).

Moreover, Neukermans et al. describe a resonant vibrational scanner that is not intended to function as an accurate steering mirror and could have excessive positional settling time because of intentionally undamped resonances that improve its scanning angle. The Neukermans et al. scanner is IC-based and employs a very small mirror that cannot handle amounts of laser power required for micromachining applications, such as semiconductor link processing. Neukermans et al. show in Figs. 9 and 11 and describe at col. 9, lines 52-60 and col. 10, lines 6-11 lenses 176 and 196 interposed between the scanner and detectors, but Neukermans et al. do not describe an entrance pupil, its position, or any effect on spot quality.

On a separate point, neither Cutler et al. nor Neukermans et al. contemplate, much less offer a solution to compensate for, a transient error signal component in laser beam position.

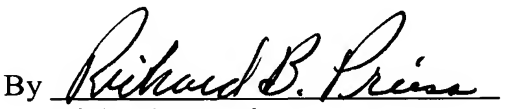
Applicants submit that no combination of "teachings" from Cutler et al. and Neukermans et al. could result in the claimed invention and believe, therefore, that amended independent claims 1 and 16 are allowable.

Regarding dependent claims 2-5, 7-9, 11-15, 17-20, and 22, the Examiner states that Cutler et al teaches the various claimed elements. Applicants submit that the dependent claims are allowable for the reasons set forth in support of amended independent claims 1 and 16.

Applicants believe their application is now in condition for allowance and respectfully requests the same.

Respectfully submitted,

Mark Unrath, Kelly Bruland,
Ho Wai Lo, and Steve Swaringen

By 
Richard B. Preiss
Registration No. 36,640

April 8, 2004

STOEL RIVES LLP
900 SW Fifth Avenue, Suite 2600
Portland, OR 97204-1268
Telephone: (503) 224-3380
Facsimile: (503) 220-2480
Attorney Docket No. 50001/84:2